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Thermal X-ray Emission from Stellar Wind Shocks in the VHE Gamma-ray Binary LS 5039

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Recent progress in gamma-ray astronomy has established Very High Energy ($> 10^{11}$ GeV) gamma-ray binaries as a new class of gamma-ray sources. Currently, the class has five binaries, all of which consist of an OB star and a compact object. Hitherto, the nature of the compact object has been established only for one system, while for the other four systems, two scenarios have been proposed: the pulsar wind (PW) scenario and the microquasar (MQ) scenario. LS 5039 ($P_{\rm orb} = 3.9\,{\rm d}$, $e = 0.35$) is one of those systems with unknown nature of compact object. The optical counterpart is an O6V star. Recently, based on the PW scenario, Zabalza et al. (2011) evaluated thermal X-ray emission from O-star wind shocks, using a semi-analytical shock structure model with no effect of orbital motion. From the lack of thermal features in the observed X-ray spectrum, they obtained an upper limit of the pulsar spin-down luminosity. In order to better contrain the pulsar spin-down luminosity, however, we need 3D dynamical models where the binary orbital motion is taken into account.

In this talk, we report on the result from 3D SPH simulations of stellar/pulsar-wind interaction in LS 5039. The shock structure obtained is significantly modified by the orbtal motion, and the thermal X-ray flux computed from the 3D distribution of density and temperature is by a large factor lower than the semi-analytical result by Zabalza et al. (2011). This significantly raises the upper limit of pulsar spin-down luminosity. We briefly discuss the possibility that the thermal features will be detectable by ASTRO-H.